TOPICS FOR DISCUSSION

at

JOINT ENGINEERING

CONFERENCE

September 24-28, 1962

GENERAL

RAILWAY

SIGNAL

COMPANY

ROCHESTER 2, NEW YORK

AUTOMATIC FREIGHT TRAIN ON CNR AT LONDON, ONTARIO

During the summer of 1960, tests to uncover the basic problems associated with the control of heavy trains were conducted on a branch of the Canadian National Railway near London, Ontario. The locomotive was equipped with coded cab signals, frequency responsive governor, and high frequency intermittent receiver. The presence of signals in the rails was simulated by currents in a loop carried by the locomotive itself. Speed-distance curves were obtained under automatic operation.

Experience obtained in this way was used as the starting point for the design of the Carol Mine System.

JDH:RGM:CB

J. D. Hughson
R. G. McAndrew

AUTOMATIC SHUTTLE TRAIN IN NEW YORK SUBWAY

The New York City Transit Authority's 42nd Street Shuttle consists of three single stub end tracks running from Grand Central Station to Times Square. Each of these tracks operates with a single train. There is no switching between the tracks and there are no intermediate stations. General Railway Signal Company has provided the equipment for operating one of these trains between Grand Central and Times Square automatically, and as such, this marks the first commercially installed automatic train operation system in the world.

The system provides completely automatic operation of the train's doors, motoring and braking and also includes an automatic dispatching system to cause the train to operate in accordance with a predetermined time schedule. Operation of the system can be described as follows: The train stands at a station with its doors open while passengers leave and enter the train. At the proper schedule time, the doors close and lock. Then the train accelerates to 30 mph and maintains this speed. At a predetermined point, the train slows to 5.6 mph and maintains this speed. At a second predetermined point, the train stops at the other station at the correct berthing point. After the train makes a proper stop, the doors open and remain open until the return trip is initiated.

The wayside equipment gives commands to the train and checks that the train obeys these commands. The equipment consists of (1) relay circuits which apply electrical pulses to the rails, (2) relay circuits which establish the direction of train movement, (3) timing sections which check train speed and accordingly control wayside train stops, and (4) ultrasonic detectors which detect train position at the station stop.

The car carried equipment includes: (1) a continuous inductive train control system for receiving commands from the wayside, (2) a frequency-responsive speed governor for electronically determining train speed, (3) a relay logic network to compare the operating command with train performance, (4) other relay circuits to determine train direction and to operate the doors, headlights, tail lights, side destination signs, etc. and (5) a control panel to place the train in either automatic or manual operation.

This system was placed in revenue service on January 4, 1962. Passenger acceptance of automatic train operation has been most encouraging.

SR:CB

Simon Reich

CAR ACCELERATOR AT ELKHART

In railroad classification yards of the gravity type (hump yards) occasionally a car will have such poor rolling characteristics that it will stop well short of its designated track. The poor rolling may be caused by the hand or air brakes not being completely released, the trucks being skewed, or other reasons. Thus a portion of the yard cannot be used until the car is moved. If this hard roller is one of the last cars of a train being "humped" the situation may not cause too much inconvenience. However, if a portion of the yard is blocked at the beginning of a train, then correction of the condition may be required.

From the above considerations it seemed to us that a small remotely controlled power unit for "accelerating" such hard rolling cars would facilitate yard operation sufficiently to warrant its cost. The control point would be the retarder operator's console.

A storage battery-operated mine-type power unit appeared to offer a minimum of maintenance and a maximum of reliability as well as providing simplicity of control and economy of operation.

The communication between wayside and the accelerator is through inductive coupling by a frequency modulated 170 kc carrier. The control information is by various combinations of three steady audio frequency tones modulating the carrier.

The stationary communication equipment consists of two electronic chassis. One chassis contains the audio oscillators, carrier oscillator and modulator while the other has the power supply for both units and the power amplifier for the modulated carrier. The carrier remains on when no control tones are being transmitted. This aids in keeping to a minimum the noise received by the mobile equipment.

The receiving equipment on the locomotive consists of a ferrite antenna, a 170 kc amplifier unit with a ratio type discriminator, a three channel filter unit, a three channel audio amplifier unit, and the three tone actuated relays. The electronic portion of the receiving equipment is completely transistorized.

One such accelerator was built and furnished for use in the New York Central Yard at Elkhart, Indiana. Unfortunately, it has not been used because of potential labor difficulties.

JDH:CB

J. D. Hughson

AUTOMATIC HUMP LOCOMOTIVE

To obtain improved operation of hump yards, it is proposed to control the speed of the hump locomotive within narrow limits by automatic means. The speed sensing device is the axle generator of our Frequency Responsive Governor. Modifications have been made to permit operation in the neighborhood of 1-1/4 mph. One of the problems is to obtain sufficiently small increments in the control of the power. In addition, anticipation must be provided to compensate for delays in train response.

The results of initial tests show that modifications in the original circuitry are required. These are underway.

RGM:CB

R. G. McAndrew

BOOSTER LOCOMOTIVE CONTROLLED BY STRAIN GAUGE

To eliminate the need for a communication link between a "master" locomotive at the head end and a "slave" locomotive midway between ends of a train, it is proposed that the "slave" be controlled locally by means of strain gauges affixed to its couplers. From measurements of force and speed, the proper setting of throttle or brakes can be determined.

Equipment is being assembled for trial on the Louisville and Nashville Railroad early in October. 1962

RGM:CB

R. G. McAndrew

CAROL MINE RAILWAY

The Carol Mine Railway consists of six miles of single track railroad connecting loading facilities at one end with dumping facilities at the other. The trains are operated without crews. At the loading end the speed of the train, as it passes under the hopper, is under the control of the loader operator. At the dumper, on the other hand, spotting of cars is achieved fully automatically. Between terminals, the trains are unattended and under the control of the signal system.

Communication from the wayside to the train is by means of suitably coded signals carried either by the rails or by loops. Between terminals, 60 cycle currents chopped 37.5, 75, 120, 180 or 270 times a minute are employed. In the dumper and loader areas, high frequency track circuits provide communication channels.

The Type K2 coding system is used for transmitting manual controls to the field locations and for returning indications to the control panel in the dumper building.

This system went into service about June 1 of this year. 1962

JDH:CB

J. D. Hughson

HIGH FREQUENCY TRACK CIRCUIT

For automatic train control, communication channels are required that provide a greater number of commands with less delay than can be supplied by conventional coded track circuits. To meet this requirement, we have developed a high frequency track circuit that operates at a carrier frequency in the range of from 1 to 2 kc/sec. The carrier is frequency modulated by tones. Six tone frequencies (67, 77, 87, 98, 109 and 120 cycles) are used two at a time to form 15 possible combinations or codes. To provide security against the self oscillation of receiver components, the tones are interrupted at the rate of 270 times per minute. A steady tone such as would be generated by a fault in the receiver is rejected.

The oscillators and amplifiers employ solid state circuitry. The tones, however, are generated and sensed by means of resonant reed relays.

This equipment is an important part of the Carol Mine Railway automatic train control system.

C. S. Wilcox

Reference: Engineering News Letter #3-62

CSW:CB

NEW CONTINUOUS CAB SIGNAL SYSTEM

For many years the decoding of cab signal information has been accomplished by the use of resonant circuits operating at frequencies of a few cycles per second. This decoding method, while very reliable, requires large capacitors, inductors, and transformers. Because of the availability of new solid state techniques, we are investigating decoding means that are based on resistance-capacitance time constants. The challenge here is to produce a failsafe system. As a by-product of this effort, we are repackaging the system completely to save cost, and to reduce size and weight.

A laboratory prototype is under test.

SR:CB

Simon Reich

RADIO REMOTE CONTROL

To reduce the size of crews required for industrial switching operations, it is proposed to provide means for an operator to control a switching locomotive while at the same time being free to couple or uncouple cars, to throw track switches, to spot cars from a vantage point and to perform like operations.

In order to control a locomotive from a location remote from its control stand, a communication means must be provided from the operator to the locomotive. Radio in its present state provides a portable, small, light-weight unit for the communication means. A simple system would provide a transmitter for the operator with means to apply modulating tones to the radio frequency.

In order to provide failsafe control, the communication system must be such that if it fails, the locomotive will stop. Thus, the commands being sent to the locomotive must be continuously received. There is no problem if one locomotive is to be controlled. However, if several locomotives are to be controlled in a limited area, one operator-locomotive communication system will interfere with another if all systems use the same radio-frequency. One obvious solution is to have different radio frequencies for each operator-locomotive combination but the number of radio frequency channels are quite limited and channel assignments are difficult to get.

Our system uses pulses of radio frequency with the modulating tones. The pulses will have about 10% "on-time" and will be about one second apart. Each pulse will have a locomotive address and command modulating frequencies. Because each operator-locomotive communication system will be "on the air" only 10% of the time, several units can operate in the one area without continuous interference.

We are providing the following basic commands: forward, reverse, advance, retard, coast, and stop. Up to eight other controls can be added. We do not expect, at this time, to provide speed control although it can be done readily.

For demonstrating the principles, we are presently assembling equipment. The modulating and coding equipment is being provided by Cardion Electronics and the radio frequency components are being furnished by Budelman Electronics.

JDH:CB

J. D. Hughson

PULSE COMMUNICATION ON BRAKE LINES

Quite a few applications for a simple train line communication system have recently come to our attention. These include the control of a slave locomotive in the middle of a train from the cab of the locomotive at the head end; the control of a pusher locomotive from the leading car of a New York Central passenger train; the means for periodically checking that the brake line of an automatic train has not become accidentally blocked.

Our interest in using accoustical signals transmitted through the air line was rekindled by the development in this country of pneumatic logic elements some of which are sensitive detectors of pressure pulses.

The basic problem is to determine the performance of the air line as an accoustical wave guide. Of interest are the attenuation rates, the magnitudes of reflections produced by bends and reservoirs, and the level of noise induced by train movement.

Some preliminary measurements made in the laboratory of the New York Air Brake Company have not ruled out the possibility of brake line communication and we are now making additional measurements using trains of cars at normal brake line pressures.

SR:CB

Simon Reich

General Reporting System for Communicating From Train to Wayside

As the result of proposals for the automatic operation of complete railway systems, a requirement has arisen for equipment that will report at specific wayside locations the current conditions aboard the train, for example, speed, engine temperatures, fuel gage readings, and the like. The wayside equipment must accept this information during the very short time that its receiver registers with the transmitter of a train that may be moving at speeds up to 90 miles per hour.

By means of an untuned coil driven by a frequency shift transmitter, the locomotive equipment emits a continuous series of 16 bit words. A bit consists of a high frequency or a low frequency pulse separated from its neighbors by center frequency pulses. Each word is separated from the others by a longer than normal burst of center frequency.

The code is formed in the following way. An oscillator drives a binary counter which in turn drives a matrix. This matrix scans contacts on the various train carried sensors that are the primary sources of information and provides a series of voltage pulses to the shift terminals of the frequency shift transmitter.

The wayside receiver is designed to have a bandpass characteristic that accepts all three frequencies. Individual detectors are used on each frequency and are arranged to produce two outputs corresponding to the binary character of the pulses received from the transmitter. The signal is read into a shift register. The shift register is checked for the correct number of bits. If the total is incorrect, the shift register is reset and the read-in is repeated. If the total is correct, the receiver output is blocked so that no further read-in can take place and the output relays are picked directly from the shift register in accordance with the stored information.

After the information has been used, the receiver is reset to accept information from the next train.

At present, one preprototype equipment has been built for demonstration.

WGP:ER

W. G. Pettitt

Car Identification System

Various applications having to do with car accounting or automatic routing have been visualized for a system which permits the identity of cars to be read automatically as they pass a wayside location. A primary requisite of such a system is that the markers attached to the cars to identify them must be inexpensive and inert.

We are presently experimenting with a system that employs a car marker consisting of a rectangular steel plate approximately 10 inches high by 9 inches long on which an array of 5/8" holes forms a seven-channel code similar to that used on teletype tape. The wayside reader consists of a source of light and a mechanical scanning disc which scans the marker in a vertical direction as it is advanced in the horizontal direction by the forward motion of the car. A logic network is provided so that the reader can discern each vertical line of holes as a character which may be either a letter or a number. The dimensions of the experimental equipment permit an identifying code to be ten characters long. Information from the marker is stored electronically until the complete set of characters has been read after which it is used to punch a paper tape which is actually merely a replica of the pattern on the marker. The tape is then read by an electric typewriter.

This equipment is strictly experimental.

LB:ER

L. Brockman

RESONANT JOINTS

Several years ago the engineers of the French Railways proposed to isolate track sections to form blocks by means of resonant joints. A resonant joint in its simplest form consists of a substantial conducting member (strap) that shunts the rails and a capacitor connected between the rails at a suitable distance from the shunt. The inductive reactance of the rails between the capacitor and the shunt in parallel with the capacitive reactance of the capacitor constitute a parallel resonant circuit, the resonant frequency of which is determined by the spacing between the capacitor and shunt. In practice, the physical arrangement is proportioned so that the resonant frequency is also the frequency of the track circuit current.

The properties of resonant joints have been investigated by engineers of AEI-GRS. In connection with our ATO developments, we have been making field tests in Rochester from which we conclude that the resonant joint is a practical means of isolating track sections provided that:

a. At least three frequencies are used, i.e., there are two blocks between blocks with the same frequency - 3.0 kc, 3.9 kc and 5.4 kc.

b. The signal levels are adjusted so as not to over-energize the track circuits.

c. Four terminal condensers are used to protect against loss of condenser units.

d. The shunt straps are as low impedance as practicable and are securely fastened in place.

e. The traction motor current (particularly d-c) does not materially change the rail inductance.

We find that practical track circuit lengths are 3500 feet for 3.0 kc/sec. and 3.9 kc/sec. and 3000 ft. for 5.4 kc.

Further tests are planned.

CSW:CB

C. S. Wilcox

ZONE CONTROL

There are many miles of railroad carrying light traffic that are operated today by means of train orders simply because the cost of installing track circuits can not be justified. In many cases the number of trains in service is quite limited and under these conditions it is reasonable to explore the possibility of devising a signal system for which most of the equipment is in the cab and very little is on the wayside. Zone control is the result of such a study.

In the Zone Control concept, the track is divided into sections by means of inert devices that serve as zone identification markers. These sections or zones play the same role in Zone Control as do the blocks in a conventional signal system. The locomotive carries equipment that reacts inductively with the zone markers and, in the absence of action on the part of another component of the system yet to be described, brings the train to a halt. To keep the trains moving, the locomotives are equipped with radio transmitters and receivers to establish two-way communication with a central control office. All transmitters, including the one at the control office, operate on the same frequency. To maintain interference-free communication, the control office, in cyclical fashion, addresses all locomotives in turn. A locomotive, on the other hand, transmits only when it is called. The zones are numbered and a given locomotive is addressed by the number of the zone that it currently occupies. Messages from the control office contain commands such as "proceed at maximum speed", "proceed at medium speed", "stop", "enter new zone". The command "enter new zone" provides the modifying action that enables the train to pass a marker and enter the next zone.

In reply to a call from the control office, the locomotive repeats the command and reports the identity of the block that it occupies. If the communication link fails in either direction, the train will be stopped by local circuitry.

Since the control office equipment knows at all times what zones are occupied, it provides interlocking protection and prevents interfering moves.

Solid state equipment has been assembled in the laboratory to demonstrate the principles. In the interim, the system has been the basis of a number of proposals for the automatic operation of mine railroads.

SR:CB

Simon Reich

INTERMITTENT INDUCTIVE TRAIN CONTROL FOR SPAIN

The recent rash of train collisions in Europe and Asia points up the need for train control systems. As a result, we are now redesigning our Intermittent Inductive System that is widely used in the U.S.A. to be more competitive in the overseas field.

Basically this redesign is to make use of modern light-weight and compact components, more adaptable to the rolling stock found in other countries.

1 A new style of acknowledging contactor of the push button variety is being incorporated which can be mounted in the control panel of locomotives or multiple unit cars.

2 A new reset contactor, identical to the acknowledging contactor, will be used in the interest of standardization.

3 The old style whistle valve is being discarded in favor of a single stroke bell to eliminate the need to tie into the pneumatic system simply for the purpose of giving an audible indication during acknowledgment.

4 Epoxy encapsulated receiver coils are to be used.

5 A new timer has been found to replace the clock mechanism which formerly was located in the acknowledging contactor.

6 A light-weight dust-proof mechanism case has been developed to house the timer, directional receiver selection relays, voltage regulator and the R-1, R-2 and R-3 relays.

7 We are also looking into the use of a solid state d.c. to d.c. converter to provide the isolated power supply which presently consists of a motor generator set.

The operation of this equipment will be very similar to that now in use.

WJM:CB

W. J. Matthews

INDUCTIVE CAB SIGNALS FOR YARDS

The need for repeating the hump signal in the cab of locomotives in classification yards was recognized soon after the first humps were placed in service.

A carrier cab signal system was recently developed to make use of modern devices and to reduce the cost. At the same time the system was expanded to make it more versatile.

In the carrier cab signal system information originating in the hump signal control circuits is converted to a frequency modulated signal at the transmitter and this signal is then fed into an overhead line (pole line). The locomotive receives this information by means of inductive coupling between an antenna mounted on the locomotive and the pole line. The received signal is amplified, demodulated and filtered to ascertain if the locomotive has been selected to receive the cab indication and, if so, what indication is to be displayed.

Four indications can be sent to each locomotive.

As many as six locomotives can be controlled simultaneously and independently.

Control of the indication to be transmitted and the selection of the locomotive to receive it can be given to the hump conductor, the yardmaster or an interlocked combination of the two.

The locomotive carried equipment is completely transistorized as is most of the wayside transmitter equipment.

At the present time this system is in service at seven classification yards for repeating the hump signal or for directing the movement of equipped locomotives in yard service.

Also this equipment is used as the communication link from wayside to train in two remote control installations.

W. J. Matthews

GRS Literature:

GRS Carrier Cab Signal System D 16.0203 dated February 1962

AUTOMATIC SPEED CONTROL FOR SEATTLE MONORAIL

1) Brief description of Monorail train as to size, propulsion system, brake system, speed, various companies involved in project.

2) Brief description of beamway as to size, layout, method of construction, power system.

3) Description of Wayside Equipment as to layout and mounting of speed control loops, number and location of cases, wayside signals, use of Ultrasonic Vehicle Detectors.

4) Description of train carried speed control equipment as to method of obtaining information from wayside, use of frequency responsive governor, tie-in with brake and propulsion equipment, overall system operation, fail-safe circuitry.

5) Future of the Seattle Monorail Installation.

W. R. Wrege

Reference: Pamphlet entitled "Automatic Speed Control for Seattle Monorail"

WRW:CB

TRAIN IDENTITY

G.R.S. Train Identity equipment is presently in service on the Erie Lackawanna Railroad, the Chicago Subway (C.T.A.) and on the Disneyland Monorail.

These systems are used to identify a particular train at a fixed wayside point.

This identification can be used to automatically align a route through an interlocking plant as is done on the Chicago Transit Authority System, to display route information on platforms, to identify trains appearing at certain control points, to detect that a train has passed a particular point, etc.

The train carried equipment for the latest system consists of an inert coil capable of being tuned to one of nine different frequencies.

The wayside equipment includes a transistor amplifier the input of which is connected to a wayside coil. The output of this amplifier is connected to a second wayside coil which partially overlaps the first coil. The output of the amplifier is also connected to as many as nine filter units. One filter and one relay are required for each frequency to be identified at a wayside location.

When the train carried coil is within range of the wayside coils, it acts as a coupling link between the two wayside coils. The wayside coils are then inductively coupled and the amplifier oscillates at the frequency to which the train carried coil is tuned. This results in energizing the relay connected to the filter unit which is tuned to the same frequency as the train carried coil. Contacts of this relay are used to distribute the desired information.

WJM:CB

W. J. Matthews

SIMULATION OF RAILROAD OPERATION BY COMPUTER

To provide a Centralized Traffic Control system for a section of railroad, the location of sidings, type of track, signal spacing, present and future traffic requirements are considered. Time-distance graphs are used to determine the anticipated performance. In some cases, actual train sheets are used to determine the basic running times of the trains. Otherwise, the times are calculated. With an IBM 650 computer available, a program was developed to make a study of single track railroad operation.

The program was written for the IBM 650 with a stored program capacity of 2000 words of instruction and data. The storage is used as follows: 350 words for grade and curvature changes, 200 words for train data, 100 words for signal location, 50 words for program entrance and exit, 500 words for calculations, and approximately 800 words for route logic. The program was designed so that changes in grade, curvature, and speed instructions could be made without affecting the signal sections. All train information such as Budd car, freight, passenger, diesel power units, weight, number of cars, length, departure time, stops, origin, destination, train number, and priority is assembled through a preliminary program into 20 words per train with a maximum of five scheduled stops. Signal sections may be marked as intermediate, approach, siding, mainline siding, double track siding and double track. All switches are considered as power switches. When one train ends its run, another is read into its storage location so that a maximum of ten trains may be operating at one time.

The output of the computer is a deck of cards from which charts similar to those produced by a train graph are constructed.

The program is presently in the hands of eight railroads. It has been compared with present traffic study methods and found to provide identical results with much less effort. The program has been used to evaluate a siding location study and the effect of the addition of trains to an existing schedule. Since the program was written, railroads have sought our assistance and used our program as a starting point in developing more elaborate programs for larger computers.

RTC:CB

R. T. Coupal
W. R. Smith

RolKode

RolKode is a new cTc system that uses an electronic roll call arrangement to provide an orderly way for multiple field stations to report over a common channel. The basic design objective is to provide a system that can use commercial communication networks whether actual channels are physical, microwave or Telstar relay links.

F. W. Brixner

Ref. Mat'l: Engineering News Letter #1-62

FWB:amd

GRS SUPERVISORY SYSTEM
TYPE PL-1

System Type

Multiple station, J relay coding, self-checking system employing full duplex carrier transmission between office and each field station. Office stepper requires 27 relays, field 25.

Capacity

Basic commands: 7 double digit.
Basic indications: 15 single digit.
Expansion by units of two J relays, each unit providing 2 commands and 4 indications.

Operation

Office stepper drives field stepper for both commands and indications.
System may be handstepped digit by digit from office for both kinds of cycles.
Stepping rate: Approximately 5 digits/sec rec.

Commands:

Each command, an odd numbered digit followed by an even digit. To execute, digits must be of opposite character. Execution takes place in "off" interval following an even digit. Delivery lasts 2 seconds for each executed command. Delivery time can be any reasonable number of seconds.

Integrity of commands by answer-back code:

Field transmits a predetermined code, a mark during each odd command digit, a space during each even unless a command is executed. Success of execution delivery changes space to mark. Office checks each answer-back digit, clears out instantly, sounds alarm if wrong.
This provides: 1. Check of synchronism
2. Proof of command delivery

Indications:

One indication transmitted as mark or space during each mark or space received from office. 100 ms. delivery during each off period.
A "mark in even digits" relay and a "mark in odd digits" relay are provided. One or the other is picked up in "off" period preceding transmission of a mark. These provide a memory for message verification.

Integrity of indications by answer-back:

For each digit "marked" by field, office follows with a "space" digit. Conversely a "space" would be followed by a "mark". By virtue of the retention of the position of the marking relays during two full digits, the field can verify correct message delivery digit by digit. Repeats complete message in event of error.

In service on a transcontinental pipeline in Louisiana. Will now be extended.

WMB:CB

W. M. Barker

PIPELINE CONTROL SYSTEM TYPE PL-2

The Type PL-2 Coded Control System has been designed to handle the telemetering of operational data from a multiplicity of pumping stations to one point such as the office of the pipeline supervisor. The system will also transmit various controls to the remote stations such as commands to stop and start compressors or requests for the telemetering of current data from that station.

Rather than employ one of our existing cTc systems, it was decided to develop a design which, unlike existing systems, would be capable of handling the overall pipeline control and data gathering over leased line circuits similar to those used for commercial teletype. With respect to transmission channels, our railroad systems fall into two general categories, i.e. one requiring the use of carrier on voice channels and the other d.c. line circuits which can be shunted to produce a sufficient change in line current to provide coded information from the field.

In considering design objectives for the new system, paramount attention was devoted to basic economy and the ability to use a low grade circuit. No effort has been made to obtain really high speed data handling since it has been felt that such a system will be of the solid state type and will have to be designed to meet the control of pipelines where the use of a centrally located computer is anticipated.

The PL-2 system operates on a start-stop principle such as used in our Syncrostep systems. All intelligence is handled by the use of marks and spaces and the integrity of the transmission is maintained by use of parity check for all codes. Each cycle consists of a group of codes, or "words". Each of these has 5 bits with 4 being used to provide binary coded decimal information and the fifth providing a parity bit. Therefore, in handling data, a cycle will contain enough words to transmit the station identification from the field and the maximum number of digits in any piece of data such as suction pressure, discharge pressure, and flow.

This new system is going to be used for the first time to transmit data from two remote locations to a supervisor's console for a crude oil pipeline running between Clearbrook, Minnesota and Lignite, North Dakota. The system will be placed in operation this Fall. 1962

N. B. Coley

NBC:CB

Solid State Indication System

Experience with high speed relay indication systems in the New York City Subways has shown that maintenance of the relays is just barely practical. Accordingly, we are developing a solid state system to meet the requirements of a current subway signal contract.

The design objective was to produce a system which would bring in 300 indications in one second with some method used to prevent the display of incorrect information. Due to the restrictions imposed by carrier equipment the first requirement is only partially met. Average delay time per indication is less than one second but maximum delay time is 1 1/2 seconds.

Operation

An Oscillator System discipline is maintained by a time-division multiplex arrangement and station counter in the office causes a narrow-band frequency shift transmitter to send out a carrier signal which after detected generates a square wave signal to drive a field station counter in step with the office counter. Synchronism between field and office is assured by transmitting a long pulse at the end of the station pulse corresponding to the last station in the system.

When the field counter reaches a count which corresponds to a station assigned to that location, a wide band frequency shift transmitter turns on and transmits 16 bits of information. This information is received in the office, detected and regenerated to the proper form for best use. It is then read in to a shift register. The first five bits of the 16 bit group received from the field carry the identity of the station transmitting the information. This station identity is compared with the identity of the station called as shown by the office station counter.

If the two are in agreement, the remaining bits which carry the indication are read into storage. If the two are not in agreement the read operation is inhibited and the storage continues to hold the last valid information received. Since the system is continuously scanning, correct information will be received on the next scan.

Preprototype equipment has been built for demonstration.

The production equipment will be installed on the New York Subway in 1963.

W. G. Pettitt

WGP:amd

SOLID STATE CONTROL SYSTEM

This system is the first system to be produced which does not use relays in the code units. It was necessary to use solid state devices in order to achieve higher speeds. Its use in conjunction with a solid state indication system assures easier compatibility.

Operation:

The equipment used in the solid state control system is, for the most part, identical with the equipment used in the solid state indication system. The operation differs in that controls are not sent on a continuously scanning basis. To assure validity of transmitted information, controls are sent twice and the two compared. Only if they agree is the transmitted information acted upon.

Prototype equipment has been built for demonstration purposes.

WGP:CB

W. G. Pettitt

Printed Circuit Boards

The following is a brief outline of what we propose to demonstrate during the week of September 24. It covers the operations performed from inception to completion and will provide a comprehensive picture of the process by which we produce prototype boards for laboratory work.

Exhibit 1.- A copy of the engineer's sketch showing location of all components and drawn on a prepared grid sheet.

Exhibit 2.- Reverse reading free hand sketch of circuitry drawn in ink on a dimensionally stable material such as mylar or cronar.

Exhibit 3.- Copy - on mylar or paper - of the circuit image as it appears on the charged selenium plate.

Exhibit 4.- Copy of transfer paper bearing toner clinging to circuit image.

Exhibit 5.- Copy of transfer paper after toner has been transferred to laminate. This will show the residue of the image.

Exhibit 6.- Fused laminate with toner image of circuit before etching.

Exhibit 7.- Etched circuit board not drilled.

Exhibit 8.- Drilled board not trimmed.

Exhibit 9.- Trimmed board not cleaned.

Exhibit 10.-Cleaned board.

Exhibit 11.-Completed board with components.

W. F. Harman

WFH:amd

Infrared Hot Box Detectors

The GRS Wheel Thermo-Scanner Unit is an infrared detector system designed to indicate wheel defects which reveal themselves by heating the wheel hubs. Defective journals, dragging brakes, loose wheels and faulty locomotive motor suspension bearings are defects which may result in heated wheels. This system differs from others on the market in the following respects: The wheel hub, rather than the journal box, is scanned; the system is 100% transistor-operated; no active elements (other than the infrared detector cells) are located at trackside.

The infrared detectors scan the lower portion of the train along a line through the bottoms of the wheel hubs. Magnetic detectors locate passing wheels accurately and control gates to select the portion of the infrared signal which is radiated from part of the hub that is within 1 to 3 inches of its center. This signal is processed to yield a constant 30-millisecond pulse which is displayed on an analog recorder or applied to data-processing equipment for automatic interpretation and signal control. The recorder may be located any distance from the scanners, the signal being transmitted to it by Data-Tran.

Presently, about 25 systems are in service on about 12 railroads.

H. C. Sibley

Ref. Mat'l: ENL #8-60 The GRS Wheel Thermo-Scanner
ENL #9-61 Wheel Thermo-Scanner

WBH:amd

Data-Tran

Data-Tran is a telemetering system developed primarily for the transmission of analog and digital pulses derived from hot box detectors. The vacuum-tube version was designed specifically to enable the superposition of the output of an existing hot box detector on a CTC line. The transistor-operated version works directly with the GRS Wheel Thermo-Scanner Unit and, with adapters, works with other hot box detectors. The transistor version was developed in order to realize the power and space savings and reliability inherent in solid state design.

Analog information is transmitted by frequency-modulation of sub-carrier tones one tone for each rail. Relays are controlled by on-off keying of these same sub carriers. A third sub carrier channel which can be shifted up or down in frequency is used to transmit two types of digital pulses plus one relay control.

Tube-operated Data-Tran has been in service on the New York Central since 1957. The transistor-operated system has been in service for over a year.

R. B. Haner

RBH:amd

SUPPRESSED CARRIER SINGLE - SIDEBAND EQUIPMENT

This system consists of a transmitter and receiver working on the suppressed carrier single-sideband principle.

The purpose of this system is to enable the intelligence derived from a hot box detector installation to be transmitted to a remote location.

There are several reasons for introducing a new design. These reasons are:
(1) A saving in spectrum space
(2) Greater efficiency
(3) Elimination of the carrier frequency

As far as we are concerned, the last reason is the most important. With the present system, the carrier frequency is at the top edge of the filters. On a long line where repeaters may be used, the modulated carrier could encounter as many as four filters. Each filter attenuates the carrier somewhat and causes the percentage of modulation to increase. To counteract this, the percentage of modulation at the transmitter must be around fifteen (15) percent in order that over-modulation does not occur at the receiver. However, with such a low percentage of modulation at the transmitter, a poor signal to noise ratio exists.

In order to design a reliable single-sideband system, the transmitter and receiver must be provided with a very stable oscillator circuit.

A crystal controlled oscillator was designed which worked very well over the range of carrier frequencies involved. The oscillator in the receiver is used to reinsert the carrier as must be done in all suppressed carrier systems.

A ring type of balanced modulator was designed for the transmitter, the output of which is the upper and lower sidebands.

An emitter coupled product detector was designed for the receiver.

At the present time the suppressed carrier single side-band equipment is in the prototype stage. All the development work, however, has been completed.

CEA:CB

C. E. Andreasen

Automatic Print-Out of Hot Box Data

This system provides a printed record of every train passing the Scanner location. The time of entering the scanner location, time of leaving the scanner location and the total number of cars are printed for every train. The numbers (counting from the head end) of cars having hot wheels are recorded for each side of the train if any abnormal wheels are detected. This system relieves the attendant of the necessity for checking the recorder every time that a train passes. It also provides for automatic operation with the printed record available to the train crews.

A system of logic which counts wheels past a nine-foot track section between two magnetic wheel detectors delineates the limits of each car in the train. The output of this logic system provides car count and allows the output of the Wheel Thermo-Scanner Unit to be identified with the cars producing the heat signal. The locomotives may be eliminated from the printed record by a logic circuit which recognizes locomotives by the fact that they have large masses in the vicinity of their lead axles (gear boxes and motors).

One system is in service on the L&N Railroad.

H. C. Sibley

Ref. Mat'l: ENL #10-61, GRS Wheel Thermo-Scanner Unit with Alarm and Printed Display

RBH:amd

Radio Controlled Switch

A tone system is provided to control switch machines over a radio channel. This system is applicable to a mine where line wires are difficult to maintain or where control from a locomotive cab is desired. The objective of this design was to provide a means to control switch machines reliably over a radio channel, even though the same channel may be used for speech transmission.

Four tones transmitted as a sequence of two pairs will operate one switch. One sequence will call for switch normal, while the opposite sequence will call for switch reverse. Too few or too many tones at a time will be rejected as a spurious signal. This coding scheme provides good immunity to false operation due to noise or speech interference. Eight tones will provide codes to control approximately 200 switches.

A system was successfully demonstrated at a Copper mine 18 months ago.

R. B. Haner

Ref. Mat'l: ENL #3-61, Radio Control of Switches

RBH:amd

Solid State Accessories for Control of Relays

Some transistor-generated devices were developed to impart special operating characteristics to standard relays, thereby eliminating the expense of special relay design or adjustment.

X-Pak makes a Type B or Type K neutral relay pulse at approximately 40 operations per minute to flash highway crossing signals.

The Start Detector provides extremely fast response to current interruption. When used in combination with a standard Type A or Type J relay it serves to detect the action of a fast relay or microswitch.

X-Pak has been tested on five railroads for several years and is now going into production. The Start Detector is in use on RolKode.

R. B. Haner

Ref. Mat'l: ENL #9-60, X-Pak
ENL #6-62, New GRS Highway Crossing Flasher Relays Operated by X-Pak

RBH:amd

GENERAL RAILWAY SIGNAL COMPANY

ROCHESTER

FOR INTER-OFFICE USE ONLY

August 28, 1962

Mr. H. C. Kendall
Director of Research

Synopsis of Analog Freight Train Simulation
for
Engineering Conference with our Overseas Affiliates

As an aid to the development of systems for automatic train operation, analog computer simulation of freight train operation has been devised which greatly reduces the engineering time required to produce a commercial system, because the controls can be applied in the laboratory to the simulated train before being installed on an actual one. The flexibility of the freight train simulator enables runs to be made with loaded trains, empty trains, eastbound or westbound, with ten cars or one hundred cars, and with a single or multiple unit locomotive with great ease.

The basis of the simulation is an electronic analog computer. In this computer, the mass of the train is simulated and the forces on it are represented by voltages. A special circuit simulates the tractive effort of the locomotive in any notch and at any speed, or in dynamic braking. Another circuit simulates the acceleration due to the air brakes, including the delay depending on train length, and the variation in the coefficient of brake shoe friction with speed.

The profile of the roadbed is punched in paper tape, and a subsystem continuously computes the average grade under the length of the train, converts this into a voltage and feeds it to the computer.

All these forces are added together and divided by the mass to obtain the acceleration of the train. This voltage is then integrated once with respect to time, giving the speed, and again to obtain distance. Every 33-1/3 feet, the distance output is reset to zero, and the output recorder chart paper moved forward the equivalent distance. Thus, the output variables are recorded as a function of distance instead of time.

This simulator has given results very close to those recorded on actual trains, and therefore can be trusted to predict accurately the performance of a hypothetical train with ATO.

Roger C. Buck
Research Engineer

as

GENERAL RAILWAY SIGNAL COMPANY

ROCHESTER

FOR INTER-OFFICE USE ONLY

August 27, 1962

Mr. H. C. Kendall
Director of Research

Synopsis on Multiaperture Devices (MAD)
as Applied to Automatic Switching
for
Engineering Conference with our Overseas Affiliates

With the advent of many new solid state devices, there has been a desire to apply these devices to perform the logic that has always been performed by relays. Many of these solid state devices were investigated for the application to automatic switching systems.

Since an automatic switching system is an "on-line" system, the solid state device used in this system has to have extreme reliability. The system also has to operate in an environment of high voltage and current transients. It should, therefore, be immune to these transient disturbances and also not be stressed by them. An automatic switching system primarily performs the logic of code storage, code switching and code transferring. The solid state device used to perform these functions must be able to perform them easily. The solid state automatic switching system using this device must be maintainable, and self indicate its operation without undue complexity.

One solid state device which fits the above requirements is the multiaperture ferrite core. When this device is assembled into a logic performing system, it consists just of multiaperture ferrite cores and copper wire. Since both are passive, their inherent reliability is extremely high, more so than for well designed, all-relay systems. Impedances encountered in multiaperture logic are in the low milliohm range and signal currents are in the order of microsecond five-ampere pulses so that transient interference simply does not exist under normal circumstances. Multiaperture cores have multiple inputs and outputs which are isolated from each other. Furthermore, these outputs are selectible and can be read dynamically and statically in a nondestructive manner.

They are best suited for shift registers and code transfer storages but are also able to perform all other logic functions as well. Since it is possible to light an indicator lamp or operate a sensitive relay directly from a multiaperture core, the operation of a MAD logic system is simple and very easily monitored and maintained.

For the above mentioned reasons, multiaperture cores are being used in developing a solid state automatic switching system of which the first will be the Canadian National Railroad Yard in Toronto, Ontario. This installation contains an 80-track, dual-hump yard and a 54-track local yard. The use of multiaperture cores allows great simplifications in the automatic switching system such as wired in interlocked codes from the push buttons which eliminates the LC relays normally required for every track. Utilizing serial transfer of codes between the hump tower and the retarder tower in the solid state system eliminates a large number of underground cables between these towers. The small size of the multiaperture cores also makes for a great reduction in space required. As a result, an entire automatic switching system for an average yard, minus switch control circuits, may be installed in a single standard 19 inch rack or cabinet. The ease in operating indicator lamps directly from a core to indicate its state allows visual observation of the codes passing through the system. Also, the direct operation of relays from these cores without amplification promotes increased reliability and reduces complexity.

The organization of the logic of the MAD automatic switching system is, in general, the same as the relay equivalent. Whenever possible, the logic was changed to take advantage of the particular characteristics of the multiaperture cores. At the present time, a prototype of a portion of an automatic switching system has been built and is operating using MAD logic.

Reference: GRS Pamphlet 933 - Automatic Switching for Car Retarder Yard

K. H. Frielinghaus
Research Engineer

as

GENERAL RAILWAY SIGNAL COMPANY

ROCHESTER

FOR INTER-OFFICE USE ONLY

August 24, 1962

Mr. H. C. Kendall
Director of Research

Synopsis on Distance-to-Coupling
for
Engineering Conference with our Overseas Affiliates

Normally, the distance-to-coupling value, used to calculate the leaving speed from a group retarder, is taken from the track circuit energy. If the track circuit fails or if there is motion on a track, another car going to the same track could not use this value. Therefore, each time a track is used, we place in storage the last value of distance-to-coupling.

In the past we have done this with relays, but after studying the use of magnetic elements, we find this can be accomplished more economically with multiaperture cores, a core being much cheaper than a relay. And, with a large saving in wiring cost, they can also be made in module form, thereby again offering additional economies.

We had given some consideration to using standard magnetic cores. There was some doubt as to the reliability of these cores due to the critical operating temperatures and coincident energy requirements. We investigated further and the MAD core appeared to be the best one available. This core was developed by Stanford Research under the auspices of AMP Inc. This company seems to be the leader in the industry, having made the greatest progress in the manufacturing and techniques to apply cores to all applications over a wide range of temperature and voltages.

It is sometimes desirable to interrogate the memory and change it if necessary. This can be done by the operator, simultaneous with the readout to the computer, providing it is not for the same track.

We feel this is an ideal core application and we are having a prototype module made for ten tracks which we hope to demonstrate.

W. R. Smith
Senior Research Engineer

as

GENERAL RAILWAY SIGNAL COMPANY

ROCHESTER

FOR INTER-OFFICE USE ONLY

August 24, 1962

All-Magnetic Logic for Fail-Safe Applications

Because of the lack of components other than copper wire and ferrite cores, all-magnetic logic systems are inherently extremely reliable. They are also small in size with no special effort being expended for miniaturization, and their simplicity leads to low cost.

It is possible to take advantage of these characteristics in safety circuits, with careful design.

We decided to use a highway crossing as the first application because, when operated from audio frequency track circuits, such a system is isolated from other signal circuits, thus avoiding conversion and compatibility problems.

In the highway crossing setup, two audio frequency shunt overlay track circuits are used in the normal fashion, with the transmitters at the outer ends and the receivers at the highway, the circuits overlapping across the highway. The d-c outputs of the receivers are used to prime multiaperture cores in the logic circuits. The two-phase clock drive for the system is derived from the flasher relay, operating continuously.

With no trains present, a logical ONE is passed back and forth between two cores, checking the presence of prime current from both receivers. These cores set others which alternately pick up and drop a relay; the motion of this relay is checked by a coding repeater relay. The lamp energy for the signals is broken over the back of this repeater.

If one of the track circuits drops, the ONE no longer circulates between the two cores mentioned above, thus stopping the output relay, dropping the coding repeater, and lighting the flashing lights. The ONE now must be passed around a loop of cores by the train creating the proper sequence as it travels over the track circuit.

If this sequence is fulfilled, the lights will be turned off when the rear end of the train is past the crossing.

In the logic, protection is provided against any number of broken wires, any single cross, failure of the driver, broken cores, etc. Of course, a break in a wire carrying lamp energy cannot be protected against.

Roger C. Buck
Research Engineer

as

GENERAL RAILWAY SIGNAL COMPANY

ROCHESTER

FOR INTER-OFFICE USE ONLY

August 28, 1962

Mr. S. W. Freeman
Vice President

Synopsis of Ultrasonic Detectors and Vehicular Traffic Control
for
Engineering Conference with our Overseas Affiliates

Ultrasonic Detectors

In the early Spring of 1959, the principal types of vehicle detectors available included pressure-sensitive, road-mounted treadles, buried magnetic loops and overhead-mounted radar doppler detectors. The principal information provided by these detectors included vehicle count and vehicle gap. These detectors while reasonably satisfactory for their intended purpose were plagued by high maintenance costs and unreliable operation.

In February of 1959, a radically different type of vehicle detector was successfully demonstrated by the GRS, employing ultrasonic ranging techniques. This detector, unlike existing detectors, was capable of sensing the presence of a vehicle whether moving or stopped. The unique advantages of a vehicle presence detector as opposed to vehicle motion or counting detectors have been demonstrated in the application of the ultrasonic detector to traffic control systems in ramp garages, parking gate installations, traffic signal actuation and expressway surveillance systems during the past three years.

The principles of operation of the various types of ultrasonic vehicle presence detectors currently being marketed by the GRS will be discussed. Brief mention will also be made of some of the newer developments of ultrasonic detectors including ultrasonic vehicle speed measurement and vehicle classification.

Vehicular Traffic Control

Vehicular traffic on city streets in the United States up until recent years has been controlled by traffic systems operating on the basis of a fixed-time program.

During the 1950 decade, several signal systems incorporating traffic responsive features were introduced which possessed numerous advantages over conventional fixed-time operated systems. These traffic responsive systems were designed around vehicle detectors capable of furnishing vehicle count, speed and gap information to central computers whose function was to control cycle length, direction of traffic progression and cross street traffic in terms of measured traffic demands. Basic weaknesses in these computer-controlled systems during periods of traffic congestion are traceable to ambiguous traffic information furnished by doppler radar units, pressure-sensitive treadles or magnetic detectors.

The development of the ultrasonic vehicle presence detector has made possible the measurement of a new traffic parameter; namely lane occupancy or the percentage of time a traffic lane is occupied by vehicles whether moving or stopped. This parameter has been shown to be an extremely reliable index of congestion.

During the past year, three new computers have been developed by the GRS based upon the concept of lane occupancy measurement. These computers are intended to be added to existing fixed-time controllers wherein the computer serves to replace the fixed-time programmer, resulting in traffic responsive operation.

Development work is currently under way on more elaborate computers employing lane occupancy measurement for the centralized control of complex interconnected city traffic signal systems.

The concept of lane occupancy will be discussed together with the unique advantages in the use of this traffic parameter as compared to vehicle count, gap, volume and speed information in the control of vehicular traffic.

H. C. Kendall
Director of Research

as

Improvements in Automatic Retardation

Since the introduction of Class-Matic retarder control at Robert Young Yard on the New York Central, attention has been directed toward simplification of the basic system and the addition of features which would make the control system more completely automatic.

A major step has been achieved in simplification by using a single test section in advance of the master retarder for the measurement of rolling resistance. This permits the use of one rolling resistance computer for determining the release speeds for the master and group retarders; thereby, markedly reducing the amount of equipment required.

The development of an automatic correction for car count distance to coupling provides a means for measuring the actual distance to the coupling point. This corrects for errors resulting from the variations in car lengths and changes in the coupling distance caused by stalls or the pulling down of cars.

The system eliminates another judgment factor from the operator's responsibility.

AVD:ER

A. V. Dasburg

Type G Car Retarder

The G-Retarder design is an extension of the Type F design. Like the Type F it is weight responsive; unlike the Type F, however, it uses a fabricated shoe beam equipped with cast steel shoes. It is operated by hydraulic cylinders.

For use in small yards and for special applications, as for example, the handling of cars in mills, the Type G retarder is intended to be a less expensive replacement for the Type E. The single rail, and therefore lighter, Type G, will produce approximately the same reduction in velocity head as will the same length of Type E retarder acting on a 100 ton car with 33 inch wheels.

The Type G retarder has a lever ratio of 1.5 to 1. In the relaxed condition i.e. with no wheels in it the shoes are spaced 5 3/16 inches apart. It will handle wheels having widths in the range from 5 1/2 to 5 25/32 inches.

Three experimental retarders have been built. Two are being used for tests on the Alton & Southern Railroad at St. Louis, Mo. and one is available for demonstration in the GRS yard.

R. B. Williamson

RBW:amd

Type F Car Retarder

This retarder was developed to meet the demand for an inexpensive mechanism that could be installed in retarder yards at the far ends of the classification tracks to eliminate the need for skates. By this arrangement a manual operation is replaced by an automatic one.

The retarder has also been used as a wheel conditioner and a grade compensator.

The Type F retarder is weight responsive i.e. it produces a retarding force proportional to the weight of the car on which it is acting. The original design was also inert in the sense that the retarder is permanently closed and always exerts a retarding force. A section of rail serving as a shoe produces retardation on the wheels on one side of the car. On the average, one foot of retarder reduces the velocity head by 0.067 feet.

To meet a special requirement on the South Buffalo Railway, a Type F retarder has been fitted with hydraulic controls for opening and closing it.

The Type F retarder is commercially available.

R. B. Williamson

Ref. Mat'l: Development Sheet D99.0601

RBW:amd

The Alton & Southern Railroad

The Alton and Southern Railroad has concluded that existing automatic retarder control systems do not achieve the desired perfection because of their inability to accurately predict the rolling resistance of cars on curved track. They also believe that radar speed measuring and conventional retarders are too expensive.

For these reasons, the railroad proposes that a simple and inexpensively operated retarder be placed near the tangent point on each classification track. The retarders are to be controlled by Alton & Southern system of speed measurement and rolling resistance prediction. The individual track retarders will take the place of the conventional group retarders. Rolling resistance tests and time distance studies are now being conducted to determine the most favorable grouping of classification tracks. It is expected that higher humping rates can be attained with this system.

The railroad also proposes the following innovations in operating procedures.

1. Only single car cuts to avoid errors in cutting and programming.

2. Programmed switching on a destination basis with interposed matrix to permit any destination to be routed to any classification track.

3. Automatic control of hump locomotive with means for programing humping speed in relation to car length.

AVD:ER

A. V. Dasburg

Ultra-Sonic Car Presence Detector

For Automatic Switching Installations

The advent of new types of cars in the U.S.A. having extra long spacing between inner axles has created a problem, because these will span the standard 55 foot detector track circuit. Increasing the length of these track circuits has the undesirable effect of reducing the maximum humping rate for short cars.

Using techniques employed in the motor vehicle detection field, an ultra-sonic car presence detector has been developed which responds to the presence of the car body when the wheels have spanned the detector track circuit. By interlocking this information with the track circuit, complete protection is provided. Thus, it is possible to select any convenient length of track circuit which will permit high humping rates.

The ultra-sonic detector can also be used as a substitute for a track circuit in certain applications.

A. V. Dasburg

Ref. Mat'l.:

Engineering News Letter - #5-62
"Ultra-Sonic Car Detector"

AVD:ER

NEW MAIN LINE SWITCH MACHINE WITH PERMANENT MAGNET MOTOR

I. Purpose

A. To provide an all electric switch machine which can be used for either subway or main line freight and passenger service.

II. Reasons For Introducing a New Design

A. To combine in one design all the features formerly included in two of our switch machines.

B. To take advantage of modern technology as well as the knowledge gained from long years of association with our switch machines and the study of a number of machines made by other companies.

C. To lower cost.

III. Design Objectives

A. Simple design having fewer parts.

B. Smaller size

C. Less weight

D. To produce a machine for operation of a single switch in the subway system or on the main line.

E. A machine made up of unit parts for easy replacement.

F. A machine to be operated by a permanent magnet motor.

G. A machine which will expose all internal parts as much as possible when a deep-sided cover is removed.

H. A machine with as few windings as possible.

J. A machine which would be as near free of frost trouble as possible.

K. A machine with sealed ball bearings to reduce number of points requiring lubrication.

IV. Operating Principles and Techniques

A. Operation and dynamic snubbing by permanent magnet motor.

B. Closed-in throw bar design to operate and hold switch points, eliminating the need for throw bar being locked by a dog on locking bar.

C. Rapid closing of point detection contacts to produce rapid opening of motor control contacts.

D. Motor locking when de-energized by magnetic detent.

E. Optional lock-out feature on single or double crank contact.

F. Point detection contacts to permit the use of neutral or polar switch repeater relay circuit and afford double break and shunt.

V. Present Status: Design stage only.

CLS:ER

C. L. Swanton

Model 13 Electric Switchman

The purpose of this project was the development of a trailable Electric Switchman. Originally, the Model 13 Electric Switchman was designed as an economical replacement for a hand switch stand in yard work. It consisted primarily of a commercial gear head motor with additional reduction and a suitable cam and switch arrangement. This provided a machine which locked the points against the stock rail in either direction when the stroke was completed. Under these conditions, an inadvertent trailing move resulted in damage to either the machine or the throw rod.

In order to eliminate this condition, a project was undertaken to make the machine trailable. In order to accomplish this, the angle through which the output crank moves has been decreased so that it now moves through an included angle of some 120 degrees, allowing a trailing move to develop a turning moment on the output shaft. The output shaft is held in position by a cam and spring detent which have been suitably modified from the previous design. These produce approximately a 1500 pound holding force of the point against the stock rail.

When a wheel moves into the points, the holding force is overcome and the points begin to move in the forced direction. At a preset point opening of one inch, the circuitry of the Electric Switchman establishes a call in the direction of trailing. The motor then moves the points to the opposite stock rail and the switch is now in correspondence with the traffic, allowing reversal of the direction of traffic without damage to the machine or the rolling stock.

To date, this machine has been successfully trailed at speeds to 5 mph and further tests will be made.

LJB:ER

L. J. Bloechl

TYPE "J" RELAY

I Purpose:
- A. General Purpose, logic and control circuit use
  - 1. cTc, pipeline, Air Traffic Control
- B. 12 to 30 volt range
- C. Permit flexible circuit design with only one type relay
- D. Long life - 250 million and extreme reliability

II Reasons:
- A. Cost reduction - drastic
- B. Make one type only --eliminate many groups
- C. Reduce size
- D. New and different

III Objectives of design - satisfy all reasons:
- A. Cost - principally three places - eliminate
  - 1. Adjustments
  - 2. Machining operations on detail parts
  - 3. Manufacturing practice on fingers
- B. One type - no choice
  - 1. Six dependent contacts
  - 2. Two independent and identical coils (either produces normal operation by itself)
- C. Reduced size -
  and disposition of parts determined by two to "A" space
- D. Something New
  - 1. Utilize modern technology and processes to accomplish objectives
  - 2. Include internal arc suppression if economical
  - 3. Use push on terminals
  - 4. Rely on previous contact experience

IV Design Principles:

In order to achieve a design that permits assembly without adjustment, operating characteristics of the relay must not vary rapidly with changes in dimensions. For example, build-up of force on contact springs must vary slowly with the position of the armature.

V Present Status:
- A. Now in commercial production- permanent tools
- B. Production testing carried out by automatic test panel
- C. Life tests to date - 143 million operations without mechanical failure

WDM:CB

W. D. Maynard

Reference: Dev. Sheet D56.7901

SAFETY RELAY

I Purpose
- A. Provide high reliability, fail-safe relay for general purpose railroad safety circuits.

II Reasons
- A. Success of "J" indicates something can be done
- B. Reduce multiplicity of groups
- C. Reduce costs
- D. Reduce size
- E. New and different

III Objectives of design
- A. Follow non adjusted principles of "J"
- B. Two types - line and track - on same frame
- C. All biased Neutral
- D. At least as good operate values as "B" relay
- E. Smaller - to utilize new standard cabinet effectively
- F. Plug coupled - but can be used without
- G. No choice of contacts - 6FB - all carbon fronts
- H. Can't make fronts with back welded - i.e. like "J"

IV Operation, Principles and Status
- A. Too early in design stage for details
- B. From theory of "J" design, some of problems can be seen.
  1. Volume of iron is a constraint requiring very effective magnetic design.
  2. 4 Ohm track coil design is a limiting size factor.
- C. Safety considerations of creepage, clearance, etc. govern design.
- D. Biased neutral - added complication
- E. Nevertheless - workable design is emerging along general principles of "J" relay using non-adjusted contacts, large area air gaps, and adequate iron.

W. D. Maynard

WDM:CB

J Relay Wiring

A new type of wiring has been developed for the J Relay in an attempt to make a drastic reduction in the cost as compared to the method used for A Relays.

The first saving was to change the type of wire used from a specially insulated wire having a coating of polyvinyl chloride covered with glass braid and in turn covered with another coating of P.V.C., to a wire having a single P.V.C. coating.

In order to use this wire safely without damaging the coating, a means of containing the wiring without using lacing was required.

An over-all plan was developed which included the use of polyurethane foam in the form of a 1" thick gasket on the back of the relay case and a similar gasket on the flat back cover.

With the cover in place the wire is held gently but firmly by the foam.

Wires coming out of the case are supported between the two layers of foam which hold them firmly in place and exclude dust. Single wires or a large group of wires can be supported in this manner without damaging the P.V.C. insulation.

This protection permits wiring between relays to be done by the point to point method.

Pre-made jumpers of various lengths are simply connected from point to point on the relays as indicated on the wire tables which also call out the proper length jumper for the location.

When several 16 way J relay cases are wired in this manner and stacked on a rack, no wires are visible except where they come out of the foam at the top of the top-most case and connect to the faston terminals directly above them.

V. C. Chappell

VCC:amd

TYPE D HIGHWAY CROSSING GATE

I. Reasons for Introducing a New Design.

A. Our Type B gate mechanisms were more complex in design and cost more to build than was considered necessary.

B. A number of our customers had asked for a faster clearing gate.

II. Design Objectives.

A. Simple design having fewer parts.

B. Smaller size.

C. Less weight.

D. Faster clearing time.

E. Designed to reduce maintenance, especially lubrication.

F. Lower Cost.

III. Operating Principles.

A. A two point control relay when energized connects 12-20 Volts D.C. from a battery or rectifier to a D.C. series motor to operate the gate to the clear position.

B. In the clear position the motor is cut off, the control relay remains energized and an electromagnetic hold clear attached to motor armature shaft holds the gate in the clear position with very little energy.

C. When control relay is de-energized the gate arm lowers by gravity with power down feature from 90 to 45° position.

D. Reversibility in midstroke either ascending or descending.

E. Contacts for control of repeater relay and bell.

IV. Present Status.

The Type B Gate is in commercial production and some are in service.

V. Published Literature.

GRS Development Sheet 52.0103

C. L. Swanton

CLS:amd

TRAIN STOP
A.C. CAPACITOR TYPE
110 VOLT 25 AND 60 CYCLE A.C.

Train stops are used on rapid transit lines to enforce proper train operation by motorman, or automatic control equipment.

1. Reasons for Introducing a New Design:
   - A. Electric stops required relatively high wattage to clear which in some cases made large energy wires necessary.
   - B. Electro-Pneumatic stops presented a problem in providing and maintaining an air line especially in outlying locations.
   - C. To reduce cost.

2. Design Objectives:
   - A. Simple design having less parts.
   - B. Smaller size.
   - C. Less weight.
   - D. Lower clearing wattage.
   - E. Unit construction.
   - F. Designed to reduce cost of installation and maintenance.
   - G. Eliminate a flexible or adjustable coupling between stop and trip arm.

3. Operating Principles:
   - A. Electrical energy required to operate and hold clear.
   - B. Removal of electrical energy causes stop to return to tripping position by return spring.
   - C. A.C. single phase torque motor drives trip arm to clear position through a gear train and overload clutch and holds it there.
   - D. Small capacitor provides desired phase relationship between motor windings for driving and holding.
   - E. Large capacitor and series resistor provides for reduced holding energy and creates a leading power factor which helps in power factor correction in the line.
   - F. Ratchet gear provides positive drive to clear but lets motor come to gradual stop in stop position. Also prevents damage to stop arm if suddenly pushed down to clear position.
   - G. Trip arm contactor available if desired.

4. Present Status
   25 and 60 cycle, 110 volt, a.c. stops have been produced and had service in busy subways.

CLS:CB

C. L. Swanton

WHIRLY-BEAM SIGNAL
(NOVEL HIGHWAY CROSSING WARNING SIGNAL)

Purpose:

To make available a highway crossing light unit which can be added to the present highway flashing signal system to provide a more arresting and long range indication. Existing design has been criticized because it does not stand out against background of advertising signs and other illumination found in urban areas.

Operating Principles and Techniques:

This supplementary signal consists of 8 light units (4" doublet with 10 volt 25 watt lamps) positioned in a circle. The signal includes a motor driven commutator on which the circuiting is arranged so that the lamps are lighted and extinguished in sequence at the rate of 60 per minute. Only two lamps are lighted at any instant. Thus the lighting sequence provides the illusion of a rotating wheel which results in a very arresting indication.

Present Status:

When demonstrated to a group of railroad men, the reaction was rather mixed. Some admit the signal serves a definite need but the cost may be objectionable. Some feel that the signal should be red while others agree to the clear which provides a stronger indication. Some feel that the strong narrow beam of the 4" doublet is fine while others believe there should be more spread at the expense of long range indication.

The prototype has been placed in the exhibit room for demonstration as required. The signal has not been commercialized.

MAS:CB

M. A. Scheg

Aluminum Cases

Because of the difference in cost between aluminum and steel, the much explored proposal of saving painting costs by using aluminum cases has not yet been widely accepted by the railroad industry.

The economic situation, however, has been altered by the availability of extruded aluminum sections that can be snapped together somewhat in the fashion of tongue and groove members. With this simplified means of fabrication, enough cost can be saved in assembly labor to compensate for the increased cost of the material.

The case is made entirely of extruded strips nested together, and welded in place. While most of the shapes are commercial items, a number of special shapes such as those required to form the 90° corners are built to our drawings and produced by our dies. The magnesium silicon alloy is highly weather-resistant.

The success of the design is dependent in part upon the use of a welding gun equipped with a motor driven spool from which the welding rod is dispensed in the form of a wire.

The cast aluminum door handles are made with the same patterns used for the standard grey iron handles.

The hinges are forged with the same dies used for the steel hinges.

The same standard internal fixtures and hardware furnished for mounting equipment in the modular steel cases are also provided for the aluminum cases.

V. C. Chappell

VCC:amd

Universal Rack

The basic principles of the Universal Rack were developed for mounting the equipment used for automatic retarder control.

The over-all dimensions are 24" wide by 26" deep by 80" high.

The corner posts are provided with holes on 1" centers which may be used to fasten angles to which 19" communication panels can be mounted.

The 1" center holes can also be used in a flexible arrangement of angles, channels or Z bars so that equipment of any shape can be mounted in any desired location in the rack.

Also provision is made for two "keyhole" channels on each side so equipment can be mounted on standard relay bars or angles by the same method used in the modular steel case or in bungalows.

A wire chase is formed by attaching 5" high sheet metal angles to the front and back of the top of the rack so that when several racks are placed side-by-side (usually bolted together) a wire chase 5" x 25" for interconnecting wires or cables is provided.

Covers are available for this chase.

Sheet metal doors with or without ventilators may be attached to front or back.

The rack may be set on the floor and bolted down or adjustable feet are available.

The same basic rack is used for all applications including; all Computer Units, Switchboards and Multiple Battery Charging Units for retarder yard installations.

V. C. Chappell

VCC:amd

FIRE CONTROL AND POLICE COMMUNICATIONS

The need for an effective, centralized police and fire control system in today's urban centers has increased in direct proportion to the population growth.

To meet this demand, several "Master Dispatch Systems" for fire and police control have been designed to achieve fast and effective coordination of municipal services. The City of Waukegan, Illinois, has recently installed a Master Dispatch System for fire and police apparatus. A centralized fire control system has been in operation for the Rochester-Monroe County, New York, Fire Bureau since August, 1960.

Under construction at the present time are Master Dispatch Systems for the Baltimore, Maryland, Fire Department, and for the Rochester, New York, Police Department.

The Master Dispatch System for fire control in the Rochester-Monroe County area is typical of such installations. It provides for the dispatching of all fire fighting facilities within a 673 square mile area. A large-scale 8' X 8' electronic locator map shows the major streets and intersections of this city-county area. Fire houses are indicated by groups of numbered, color-coded lights. Each light indicates the status of an associated piece of equipment. An electronic Dispatch Console coordinates all communications with multi-phone circuits, with special lines to city and county fire houses. The console also feeds information to a Locator Map through status panels. To the dispatcher, a fire becomes a row of tokens, numbered and colored for quick identification as to type of apparatus. A glance at the "On Assignment" panel, for example, tells the dispatcher the exact number and type of fire apparatus assigned to each fire.

Monitoring of communications, by 'phone or radio, in the Rochester-Monroe County system is accomplished through a Command Station, which affords a full view of the electronic Locator Map, and instantly acknowledges deployment of equipment as its coded lights inform the operator of changing status patterns.

TJJ:CB

T. J. Judge

SA1 SIGNAL

Reasons for Introducing a New Design:

To provide a new searchlight signal which will be interchangeable with the SA, the new unit to incorporate mechanical improvements without sacrificing the desirable features of the SA. Resistance and operating values to remain unchanged.

Detailed Design Objectives to Reduce Manufacturing Costs:

To increase working magnetic air gaps and have these air gaps exposed so that they can be readily checked. The increased air gaps provide a greater margin of operating safety.

To provide a slant spectacle arm so that white light entering signal from front will be reflected out of color beam and thus prevent beam dilution.

To improve back contact performance by increased pressure.

To eliminate soldered connections.

To improve insulation and provide built-in lightning protection.

To change coil from movable to stationary half of magnetic structure.

To assemble permanent magnet to rotor which eliminates the need for operating the rotor shaft inside the operating coil.

Operating Principles and Techniques:

Signal mechanism operates exactly as heretofore. Some light rotor centering springs have been provided to facilitate final calibration of operating values. The tension of these springs can be easily altered.

Present Status:

New structure has been fully commercialized and 100 units produced to check tooling. Regular production will commence pending the exhaustion of present stock of SA signals and parts.

M. A. Scheg

Reference: GRS News Letter 7-61

MAS:CB

VISUAL GLIDE SLOPE INDICATOR

In making an approach to an airport runway even under conditions of good visibility, it is sometimes difficult for the pilot of a light aircraft to judge the inclination of his glide path. To aid the pilot during this critical maneuver, the Federal Aviation Agency has been experimenting with several different visual means for defining a plane inclined at the proper slope for an ideal approach path. These devices are called Visual Glide Slope Indicators. An important requirement is that the equipment be sufficiently inexpensive to permit its installation at a large number of the smaller airports that are used principally by small airplanes.

To meet this requirement, we have modified our Tri-Color Directional Lantern that was originally designed for the use of the United States Coast Guard in establishing over-water courses.

This device is essentially a high intensity projector such as is used to project lantern slides. In this case the slide is a combination of a red filter and a green filter with a white area between them. The optical system is arranged to form an image at an infinite distance. When the projector is pointed in the direction of the desired glide slope, it provides a three color indication. When the aircraft is on the proper glide slope, the pilot sees a white aspect; when it is above the glide slope, he sees a green aspect, and when it is below, he sees a red warning aspect. Variations of this arrangement are possible.

To provide the necessary viewing range under daylight conditions, we have equipped our Tri-Color lantern with a special high intensity quartz lamp.

We are preparing to furnish prototypes to the Federal Aviation Agency for evaluation.

FSC:CB

F. S. Craig

Selenium Rectifiers

The new line of Selenium Rectifiers has been started with two models- Type S and Type ST which replace Copper Oxide Type B and Type BT.

The Type S consists of a rectifying unit in a case provided with AAR terminals.

It is for use with Type K or Type U transformers and is available in ratings from 10 to 30 volts dc and up to 3.5 amps.

The Type ST consists of an assembly of a selenium rectifying unit and a variable reactive transformer. All assemblies are designed to operate from a primary source of either 115 or 230 volts at 60 cycles. This selection is made by changing primary taps on the reactive transformer.

The adjustment of charging rate is obtained by means of a micrometer adjustment of a sliding yoke on the transformer which changes the magmeter coupling between the primary and secondary.

Assemblies are available in various ratings for charging from one lead cell to 14 lead cells at charging rates up to as high as 3.25 amps on same models.

Ratings of these rectifiers are conservative for long life, and are based on a maximum ambient temperature of 160° F for an expected life of 10 years.

All the Type S and Type ST rectifiers use the same basic case and will mount in the space required for a Type B-2 relay.

V. C. Chappell

VCC:amd

Miniature Track Diagrams

In cTc and similar systems, the control of ever more territory from one point has resulted in large panels for the display of the field indications. Especially in the Traffic Master concept, where all of the control buttons are well within arm's reach, the panels must be mounted at a considerable distance from the operator simply because of the relatively large size. The minimum dimensions of the panels are dictated by the center-to-center distance of lamp sockets. In some instances, existing structures are too small to house these panels, necessitating expensive building alterations.

Hitherto, the lamp with the smallest frontal area has been the slide base telephone lamp. The bulb is 1/4" in diameter and requires side wire terminals. The minimum practical socket center-to-center distance is 9/16 inch. The introduction of the T-1 flange base lamp has made possible a design of lamp socket module for track diagrams with lamps at 0.203 inch center distance. These lamps are quite expensive, but become practical because of the extremely long life (about ten years constant burning). This long life is achieved at the expense of low light efficiency.

Typical Lamp Data

No. 682 5.0 volts, 0.060 amps, 0.30 watts, 0.029 candlepower (0.365 lumens), 10.34 watts per candle (1.217 lumens per watt), 100,000 hours life.

The low candlepower of the lamp makes it imperative to conserve as much of the light flux as possible to yield sufficient brightness at the color cap to give adequate contrast. Another design objective was to make the color cap imperceptible when the lamp is not lighted.

The lamps are inserted in cylindrical holes in a sintered metal module. The material is nickel-brass alloy having good diffuse reflectivity and good thermal conductivity. It acts to direct much of the light to the thermoplastic color disc by successive reflection in the cylindrical hole and acts as a good heat sink. When its lamp is not lighted, the color disc is not distinguishable against the black track line, on the silk screened panel. There are 63 lamp holes in each socket module.

Panels using these components are in commercial production.

KWA:ER

K. W. Abendroth

Impact Detector

An impact detector was designed as a low cost disposable device which would discourage rough car handling and consequent damage claims.

Expensive instruments are available which are installed inside box cars by shippers. These generally draw continuous charts of time vs. acceleration, often in three planes.

A market should exist for a simple once-use device in the general category of a car seal. Attached to the exterior of a car, a glance should reveal whether the car has suffered possible lading damage. Thus, a car would not be accepted at a transfer point as in good order, if the impact recorder were found tripped.

The impact recorder, or responsibility fixer, is housed in an injection molded thermoplastic case. The front and back halves are identical. Inside, lead weights are attached to pivoted arms which are restrained against stops by calibrated coil springs. A separate arm assembly is provided for forward and reverse directions. When forces, due to acceleration, exceed the design value, the arm toggles over center and a brightly colored flag (actually the side of the weight) is visible through a transparent portion of the case. The arm cannot be restored without taking the case apart. A lead seal wire is threaded through drilled holes in the mounting bolts.

Prototypes of the responsibility fixer have been made and tested on railroads. Thus far, they have been used to confirm retarder adjustments in classification yards.

KWA:ER

K. W. Abendroth

AIRTRAC

Airtrac takes its name from the words AIR TRAffic Coordination. As presently being applied, this is a system for posting flight information in front of air traffic controllers at separated points and includes the capability of interlocking assignment of space positions by limitations on the posting or changing of data in the various positions according to the control status of that position at a particular time.

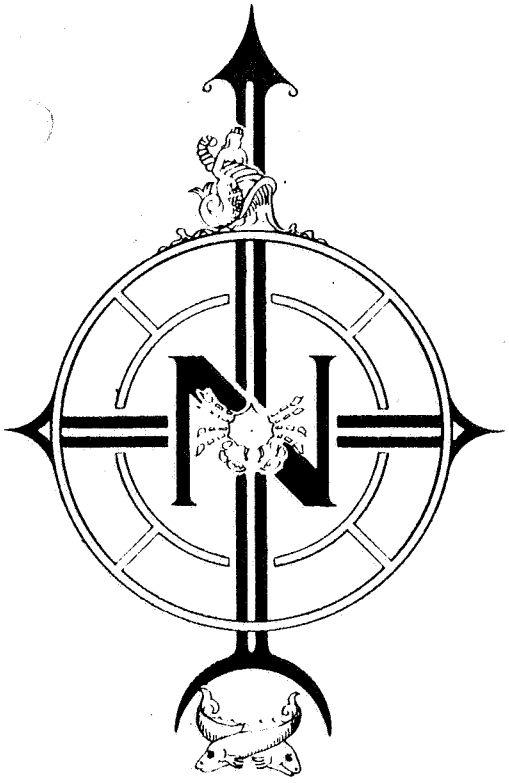
The overall purpose of this kind of scheme is to provide immediate status information to each of two controllers who share the use of air space without the use of voice communication which has otherwise been used for coordination between such controllers. When voice is used to establish changes in space assignments, it necessarily occasions delays because both parties must simultaneously be free to talk and/or listen and such time is at a premium because they are already using voice communication repeatedly to the aircraft which they are controlling. In the earlier mechanical interlocking system, this coordination by pushbutton-lights was found very useful and speedy but required separate means for handling data since only the space assignments were interchanged.

Airtrac, as now proposed, provides a possibility of posting data on Post-Rite indicators so that in addition to providing the interlocking, the system will have data communication facilities. The most promising applications for this type of system are for coordination between a large terminal and the air traffic center which handles the traffic for a large area, approximately 200 miles square. The system would handle data and assignments relating to the departures and arrivals for this terminal with the route center.

The system includes components and subsystems for (1) posting rows of data on indicators from an alpha-numeric keyboard similar to a typewriter, (2) for transferring a row of data to another row, (3) for transmission of a row to a remote unit, and (4) for making permanent punch tape records of data that have been displayed. Since, in many cases, it is desired to operate the keyboard input more rapidly than the indicators can post, the system has included buffers so that the keyboard may be used at maximum rates. A prototype of this system has been built to demonstrate the capabilities outlined above and has been displayed to various air traffic officials. It will be available for demonstration.

SMP:CB

S. M. Phelps



Not this . . .

. . . but this

FUNCTIONAL DRAFTING

THE APPLICATION OF THE CONCEPT OF "SIMPLE YET SUFFICIENT" TO DRAFTING ROOM PRACTICES.

W. F. Harman